Space Weather Technical Forecast

Issued on Saturday, 19 November 2022 at 01:05 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/Minor Storms, mainly day 2 (20th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low levels, with a number of C-class flares. These are primarily from complex sunspot regions which have rotated across the western limb, but also from a recently developed sunspot region AR3150 Dai/Beta, which rapidly emerged on the northwest quadrant and produced a C4 flare at 18/1945UTC. Significant growth of this region appears to have recently stalled, although there is some spreading evident in its observable spots. There are a further three small and benign sunspot regions, two on the southeast disc, AR3147 Hsx/alpha and AR3148 Cro/Beta, and one on the northeast disc, AR3149 Hrx/alpha. No Earth-directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: A weak transient likely passed across L1 during this period, likely associated with a weak CME that left the Sun on the 14th. The solar wind speed, as observed at L1 persisted at slow background speeds, albeit slightly increasing from around 310 to 380 km/s. However density started below average before rapidly rising from 18/0400 UTC to peak above average at 20 ppcc by 18/0810 UTC. This then dropped out to be below average from 18/0848 UTC, but climbed to give another period of above average density 18/1500-2230 UTC, before dropping out again. The total IMF strength, Bt, was generally weak at 4-6 nT, but rose to mainly Moderate levels 8-12 nT from 18/1630 UTC. The north-south component, Bz, was mainly weakly negative (southward), but became moderately negative briefly, reaching a peak negative value of -9 nT at 18/1720 UTC. The field then erratically rotated back to neutral values. Phi angle was generally negative (towards the Sun), but with two rotations to positive (away from the Sun) 18/0530-0845 UTC and 18/1635-2225 UTC. Geomagnetic activity was Quiet to Unsettled.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 has remained at background levels. High energy electron flux (greater than 2 MeV) at GOES-16 has been at background to moderate levels, with a peak of 245 pfu at 18/1225 UTC. Electron fluence levels remained well below Active (1e8 integrated pfu) levels, with a level trend. Observed fluence at 19/0000 UTC was 7.77e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be mainly Low, with further C-class flares likely and a slight chance of M-class flares. The main risk is from developing sunspot AR3150 in the northwest.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Initially background winds are expected to become enhanced due to the arrival of fast wind from CH46/-, although confidence is low on the timing of the arrival. Any preceding CIR region is likely to arrive later day 1 (19th), with a transition into the HSS through day 2 (20th). Fast winds are then likely to persist on the 22nd (day 3), before gradually receding later in the period. Quiet, isolated Unsettled, geomagnetic activity at first becoming Unsettled to Active later day 1 (19th), with a chance of G1/Minor Storm intervals, most likely day 2 (20th), but potentially also late day 1 (19th) or day 3 (21st). Activity easing to Quiet to Unsettled with a chance of Active intervals by

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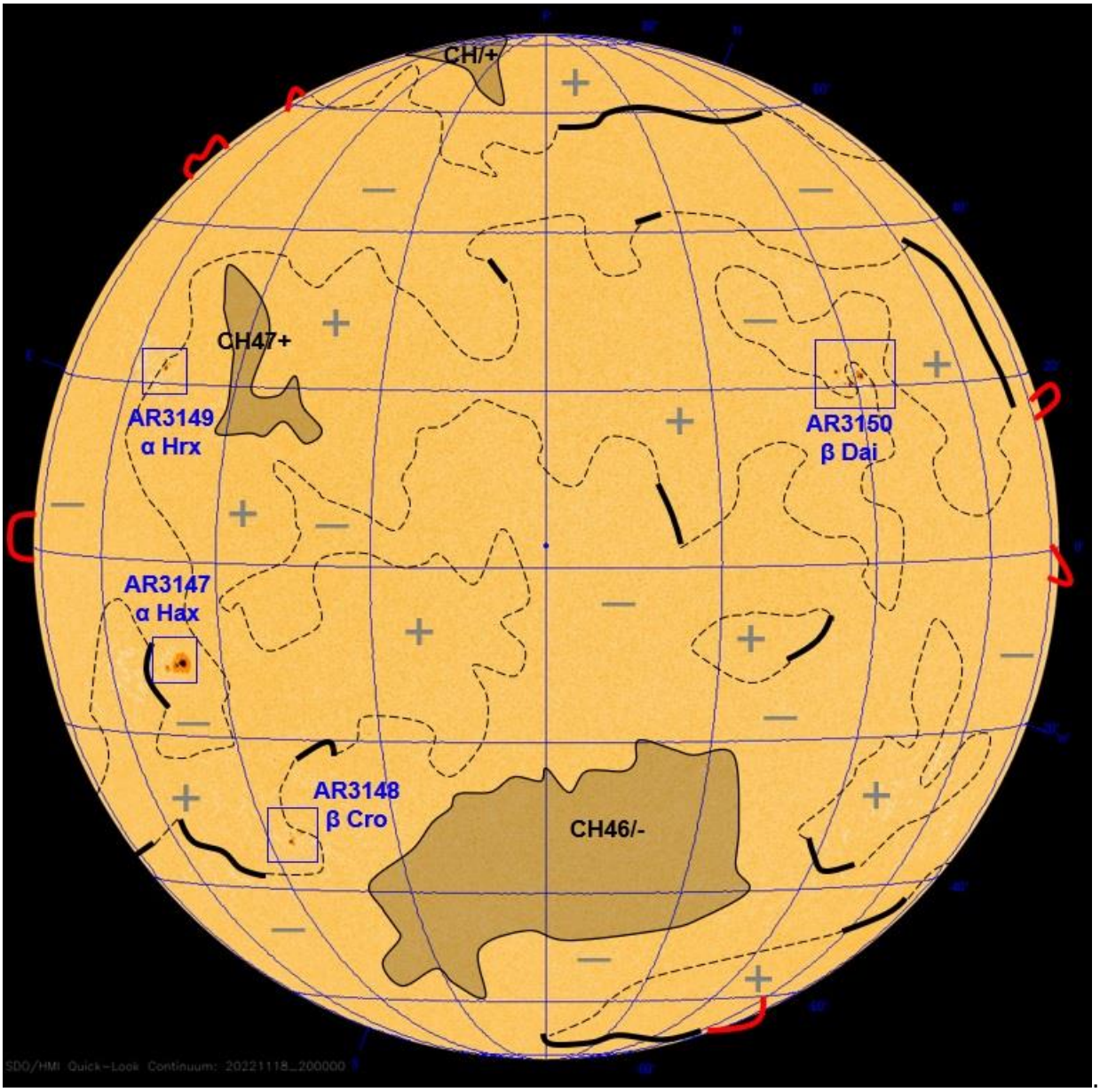
day 4 (22nd).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) observed by GOES-16 is expected to remain at background levels throughout. Electron flux is forecast to be initially at background, but with a chance of rising to Moderate, perhaps High, later in the period as solar winds ease after any enhancement from the arrival of CH46/- fast winds. Fluence values are expected to remain below or well below the Active (1e8 integrated pfu) threshold throughout, but with a chance of rising above by day 4 (22nd).

Figure 1. Solar Analysis Valid 18/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs in this forecast period. Solar winds are currently at background with the next significant enhancement expected to be from a fast wind arrival, with the onset of the high speed stream (HSS) of negative polarity coronal hole 46, although the timing of this arrival is low confidence.

This is a broad feature is the southern hemisphere with 27-day persistence suggesting the arrival of any associated co-rotating interactivity region (CIR) ahead of the HSS occurring during the 2nd half of day 1 (19th), whilst Enlil has the associated arrival early day 2, around 12 hours later. Despite the unfavoured time of year for a strong geomagnetic response, this is a persistent feature perhaps indicating a stronger CIR than would otherwise be expected. Furthermore Enlil indicates a potential for solar winds to peak at around 600 km/s by day 3 (21st), before then easing gradually day 4 (22nd) onward

Quiet, isolated Unsettled, geomagnetic activity at first is expected to become Unsettled to Active later day 1 (19th) with the fast wind onset, with a chance of G1/Minor Storm intervals, most likely day 2 (20th), but this risk potentially continuing on day 3 (21st). Activity easing to Quiet to Unsettled with a chance of Active intervals by day 4 (22nd).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	40	20	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2a: MOSWOC solar wind persistence model Enhancement likely later on the 19th, peaking later 20th.

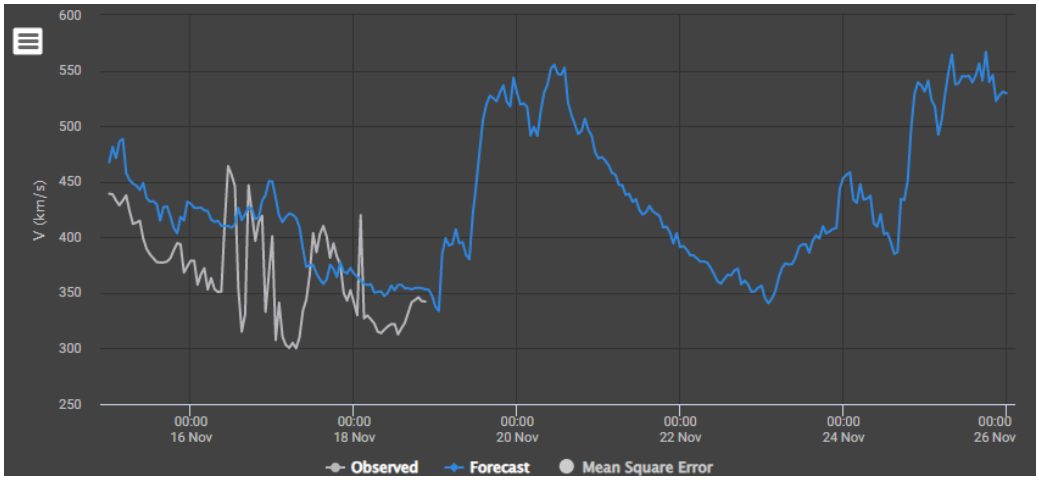

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Figure 2b: Enlil Indicates arrival early on the 20th, peaking 21st.

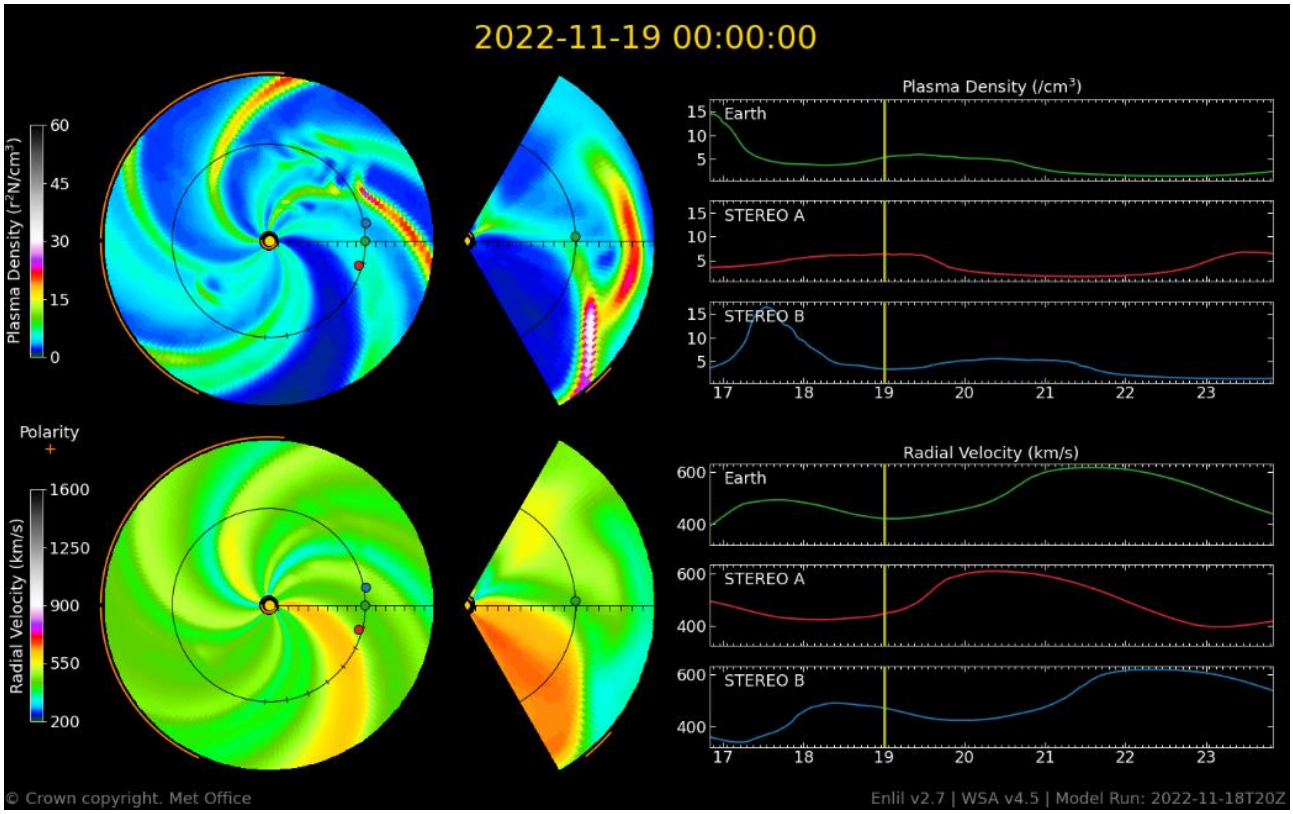
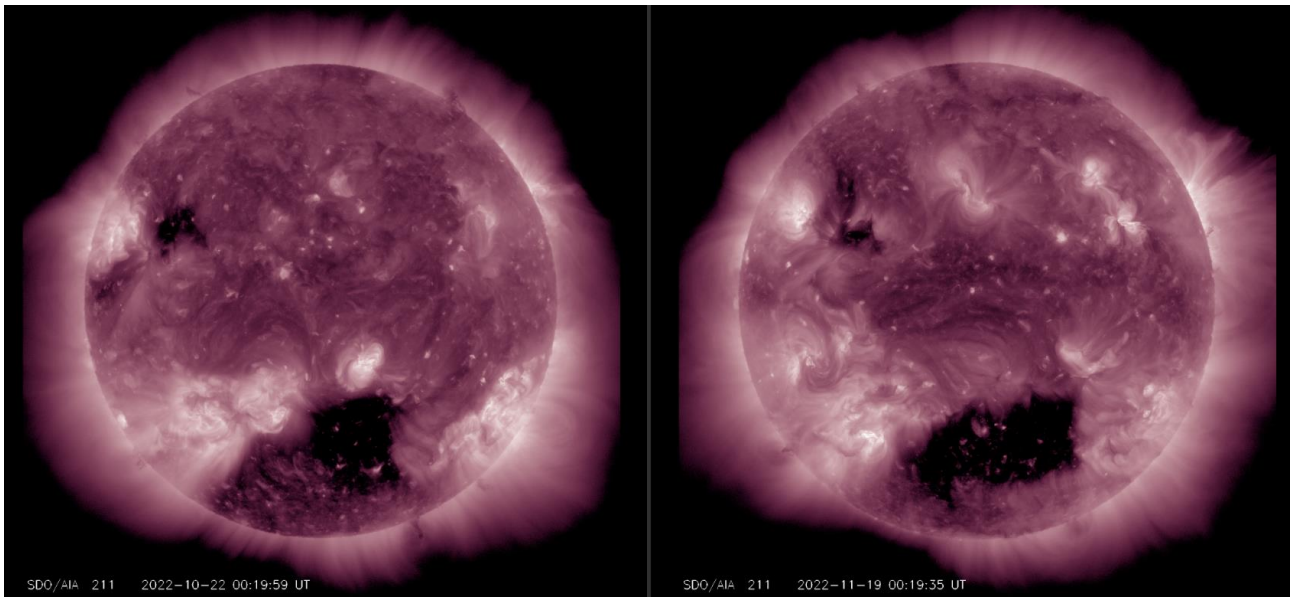


Figure 2c: SDO Aia-211 of current rotation and previous rotation. Suggesting good confidence in SWPM, with similar CH structure on this occasion.



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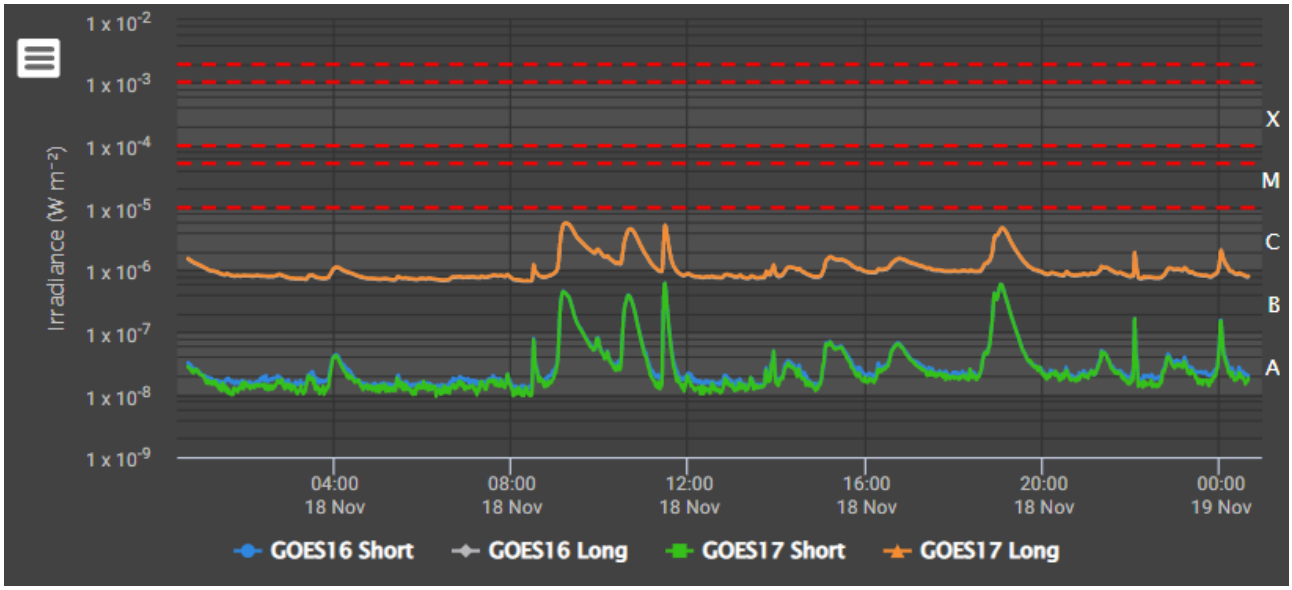
Radio Blackouts - X-Ray Flares:

Solar activity is currently Low with occasional C-class flares and four small and relatively simple sunspots on the Earth-facing disc. This activity is forecast to continue with only a slight chance of M-class flares.

AR3150 Dao/Beta in the northwest is the most development region on the disc, with rapid growth observed on the 18th. This has subsequently stabalised into a small and spreading region, but remains the most likely source of any M-class flaring day 1, with the subsequent risk decreasing due to low confidence with any further development. The other three regions are all smaller, simpler and largely stable.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	20	15	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES16 X-ray Flux



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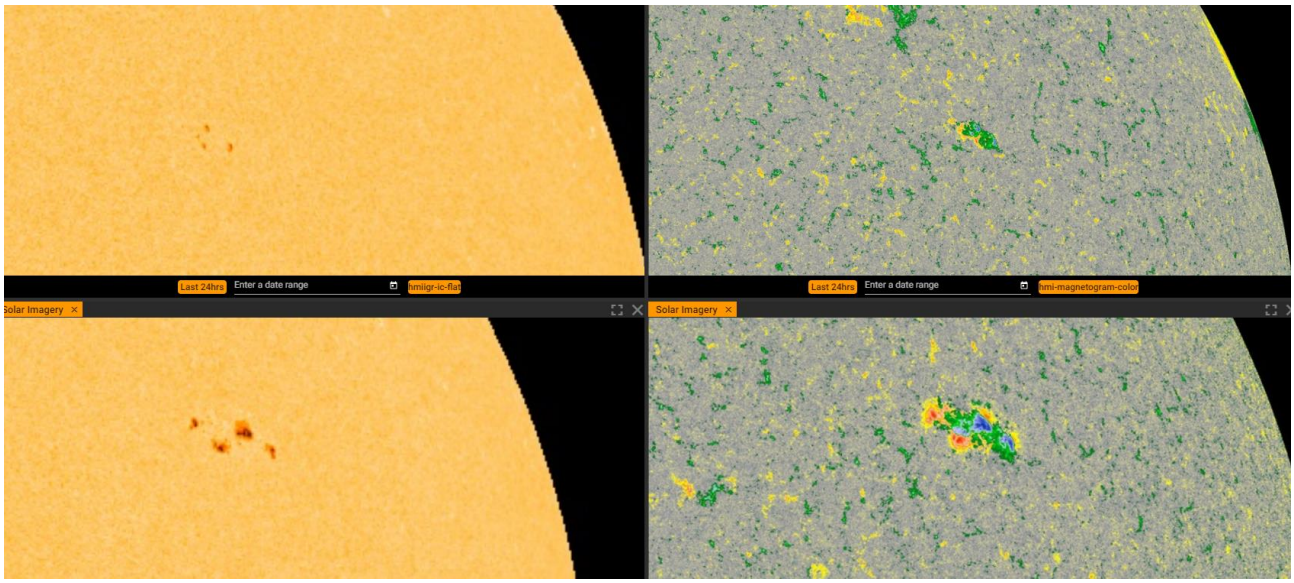
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) at GEO, as observed by GOES-16 is currently at background and expected to persist at this level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: SDO Intensitygram and Magnetogram of AR3150 at 18/1000 UTC (top) and 19/0000 UTC Fairly rapid growth evident, but now largely stalled.



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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES-16 is at mainly Background, briefly Moderate, levels, and well below the Active threshold. Upcoming solar wind enhancement later day 1 and through to day 3 (19th-21st) has the potential to increase the electron content in the Van Allen belts, although these will initially be compressed inside of GEO. As solar wind pressure eases later in the period, the observed flux is likely to rise, perhaps reaching Moderate to High levels. The strength of any response is very low confidence however, with no increased flux observed on the previous pass of this coronal hole, 27 days ago.

The associated 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) threshold, but with a chance of rising above by day 4 (22nd). REFM is currently giving good guidance, however this will become less reliable with the expected solar wind enhancement.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	10	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES-16 Electron Flux (top) and Fluence with REFM and Recurrence

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